THIS DOCUMENT CONSISTS OF 98 PAGE(S)

SECRET

UNITED STATES
DEPARTMENT OF ENERGY
NUCLEAR EXPLOSIVE SAFETY STUDY GROUP

NUCLEAR EXPLOSIVE SAFETY STUDY OF B53 MECHANICAL DISASSEMBLY OPERATIONS AT THE USDOE PANTEX PLANT (U)

OCTOBER 1, 1993

RESTRICTED DATA
THIS DOCUMENT CONTAINS RESTRICTED DATA AS DEFINED IN THE ATOMIC ENERGY ACT OF 1954. UNAUTHORIZED DISCLOSURE SUBJECT TO ADMINISTRATIVE AND CRIMINAL SANCTIONS.

CLASSIFIED BY A. A. Nichols ORG. NESS
TITLE Chief, WSSB DATE 10/12/93

SECRET

DEPARTMENT OF ENERGY DECLASSIFICATION REVIEW

1ST REVIEW-DATE: 02/06/97	DETERMINATION [CIRCLE NUMBER(S)]
AUTHORITY: ☐AOC ☐ADC ☐ADD	1. CLASSIFICATION RETAINED
NAME: R.J. Graves	2. CLASSIFICATION CHANGED TO:
2ND REVIEW-DATE: 2-7-97	3. CONTAINS NO DOE CLASSIFIED INFO
AUTHORITY: ADD	4. COORDINATE WITH:
	5. CLASSIFICATION CANCELLED

[redacted]

B53 Warhead Electrical System. The elements of the B53 electrical system associated with the bomb firing system are the lightning arrestor connector (LAC), the MC4065 power pack, the MC1199 electrical system safing switch, two MC4066 neutron generators, the MC744B X-unit, two MC1262 fast-rise thermal batteries, and two MC1264 thermal batteries. The B53 bomb arming and firing system is dual-channel except for the capacitor bank, and the spark gap.

The LAC provides the electrical interface to external sources of electrical energy and in conjunction with the MC2969 strong-link switch protects against electrical energy from a lightning strike. The LAC is located at the bomb/pullout cable interface.

The MC4065 power pack contains a high voltage transverter, a trigger circuit, the neutron generator low voltage attenuator, and the MC2969 strong-link switch which are potted in a stainless steel housing. The MC2969 is enabled by a unique signal provided by a source external to the bomb. The MC2969 interrupts all electrical lines, except electrical ground, going into the firing set. [redacted]

The MC1199 electrical system safing switch is manually operated and provides visual indication of the switch position (safe, retard, or free-fall). The handle of the MC1199 is mechanically locked in the safe position by a solenoid-operated pin. The MC1199 may be operated to

the safe position with or without power applied to the solenoid.

[redacted]

DOE b(3)

C

Two MC1262 fast-rise thermal battery packs are used in the B53. The MC1262 is a two-section thermal battery containing a 12-volt fast-rise section and 28-volt power section. [redacted]

Two MC1264 thermal batteries are used in the B53 to provide dual channel power for the fuzing system. The MC1264 is nominally a 28-volt battery with an activated life in excess of 240 seconds. It is activated by electrical power from the 12-volt section of the MC1262.

Nuclear Explosive Safety Theme. Although the B53 was not developed with modern design criteria, several abnormal environment nuclear explosive safety design features have been added to enhance nuclear explosive safety. The nuclear explosive safety theme of the B53 involves energy diversion through conductive metal barriers, exclusion of electrical energy into the firing set by a strong-link switch that is enabled by a unique signal, and location of the strong-link near the weak-links. A LAC is used at the bomb/pullout cable interface to provide protection against electrical energy to the bomb that could result from lightning strikes. [redacted] Also, all B53s in stockpile are inherently one-point safe.

Permissive Action Link (PAL). The B53 does not have a PAL capability.

Command Disable (CD). The B53 does not have a CD function.

Non-DOE Components. All components of the B53 are DOE's responsibility.

[redacted]

Shipping Configuration. The H794 Hand Truck is a caster-mounted metal truck used for shipping, storage, positioning, and maneuvering of the B53. The H794 is approximately 10 feet long and 5 feet wide and weighs approximately 1000 pounds. The bomb is held in place by two aluminum bands and longitudinal movement is resisted by a telescoping steel shear pin.

Tiedown Specification for On-Site and Off-Site Transportation of the B53

Tiedown requirements for movement of the B53 at the Pantex Plant and over-the-road were reviewed by the NESSG. Sandia National Laboratories (SNL) provides the tiedown patterns used for on-site movement of nuclear explosives at the Pantex Plant. Tiedown requirements for over-the-road are provided to Mason & Hanger-Silas Mason Co., Inc. (M&H), through the Technical Publications 45-51 series. Test data and/or analysis used by SNL to determine tiedown patterns and tiedown materials used in the tiedown of B53 are available at Organization 9613, SNL, New Mexico, have been reviewed, and meet the criteria established in Reference B for on-site transportation and Reference E for over-the-road transportation.

Chemical Compatibility

The materials compatibility program conducted tests to ascertain continued safety of all nuclear explosives when subjected to chemical interactions between materials or chemical aging throughout the stockpile life. No increased safety risks due to chemical compatibility problems have been identified. Also, the explosive compatibility program shows that there are no incompatibilities with the materials and surroundings found at the Pantex Plant and the B53 HE.

HE Aging

Selected properties of Cyclotol and Composition B have been evaluated from aged stockpile materials and local testing. There are no signs of degradation from aging or incompatibility.

One-Point and Criticality Safety

Los Alamos National Laboratory (LANL) certifies that all B53s remaining in stockpile have been individually calculated to be inherently one-point safe. [redacted] LANL also certifies criticality safety, even in abnormal environments, provided only that the primary remains intact. Also, for as many as 10 undamaged B53s, there are no criticality concerns for any spacing/arrangement.

DOE b(3)

5

Response to Pantex Plant Abnormal Environments

Appendix B provides information about and the response of the B53 in configurations C and D to the identified and defined abnormal-environment threats at the Pantex Plant. The nuclear explosive safety design features of the B53, the Pantex Plant facilities where the B53 will be processed, and nuclear explosive safety controls and procedures in effect at the Pantex Plant combine to result in a predictably-safe response (no worse than a one-point detonation) to all identified and defined single and multiple abnormal-environment threats at the Pantex Plant for each configuration of the B53, except for tornado. The NESSG believes that an aircraft crash could also result in an unpredictable response. An unpredictable response would require the bomb center case to be breached, a compromised firing set, an appropriate energy source, and an intact primary. It is highly unlikely that a force strong enough to breach the bomb center case would leave the main charge detonators, high explosive, and pit undamaged. Additionally, the appropriate energy would have to be applied to more than one detonator simultaneously since the B53 is inherently one-point safe. The protection provided in Zone 4 and Zone 12 structures of the Pantex Plant, the nuclear explosive safety controls and procedures in effect for all nuclear explosive operations, and the rugged construction of the hardened trailers significantly reduce the threat to nuclear explosive safety of the abnormal environments. The NESSG believes that the possibility of the tornado or aircraft crash resulting in a threat to nuclear explosive safety is remote.

Reader-Worker Procedures and Checkoff Lists

Reader-worker procedures and checkoff lists are required and in use for those B53 mechanical disassembly operations requiring person-to-person coverage.

Additional Information

Additional information about the B53 and about the operations associated with the B53 is in Appendices B, C, and D.

Issues Resolved Without a Finding

1. A PT4118 multicircuit continuity tester is used to verify the safe position of the MC2969 strong-link switch before disassembly of the nuclear

explosive. The NESSG proposed that this test be performed only once after bomb return and that the test be performed in the Zone 12 disassembly bay. This action was agreed to by M&H and SNL. It shall be implemented prior to resuming B53 disassembly operations and the applicable operating procedures shall be revised by M&H and verified by DOE/Amarillo Area Office (AAO).

2. M&H and SNL proposed delaying removal of the protective shroud over the detonator cables to reduce the vulnerability of the nuclear explosive and thus the requirements for person-to-person coverage. The NESSG agrees with this proposal. Removal of the protective shroud shall occur as late as possible in the disassembly process. This change shall be implemented prior to resuming B53 disassembly operations and the applicable operating procedures shall be revised by M&H and verified by DOE/AAO.

3. M&H proposed to stage the end cap assembly (primary) in Zone 12 prior to its disassembly operations. Staging will be accomplished in a new stand that is similar to the old stand, but with provision for a totally enclosing metal cover and protective blankets. The NESSG agrees with this proposal. After receipt of this tooling and before resumption of B53 disassembly operations, the tooling shall be reviewed by Battelle Pantex/Nuclear Explosive Safety Division (NESD) and DOE/AAO/Nuclear Explosive Safety and approved by DOE/AL/NESD. Prior to resuming B53 disassembly operations, the applicable operating procedures shall be revised by M&H and verified by DOE/AAO.

Conclusions

The NESSG concluded that References A through G are valid, appropriate, and adequate and are applicable to the studied B53 operations. The NESSG also concluded that the procedures, equipment, and administrative controls to be employed with the studied operations are not a threat to nuclear explosive safety and meet Nuclear Explosive Safety Standards a., b., c., and e. and other nuclear explosive safety criteria of DOE Order 5610.11; except that portion which has not been implemented, as specified in Appendix A; and of AL Supplemental Directive 5610.11. Nuclear Explosive Safety Standard d. is evaluated by the DOE/AL, SNSD's security surveys and DOE Headquarters' inspection and evaluations of Pantex Plant security operations.

I. SCOPE

The scope of this Nuclear Explosive Safety Study is limited to those operations performed during B53-1 disassembly for removal of parent unit parts to be used during Joint Test Assembly build. These operations include on and off-site transportation of the B53-1, disassembly of the B53-1 through removal of the firing set (power pack and X-unit) from the aft cap, reconstitution of the remaining material into a BA53-like assembly, and on-site transportation of the BA53 to storage. Specifically excluded from this study is disassembly of the nuclear system.

II. DESCRIPTIONS

A. General Description of Bomb

The B53-1 is a thermonuclear device, approximately 148 inches long and 50 inches in diameter weighing approximately 8850 pounds. It consists of a nuclear system and electrical system components. The bomb provides only a laydown option and is timer armed and fired. The bomb consists of a Basic Assembly (BA) and Basic Shape Components. A view of the shape components exploded away from the Basic Assembly BA is shown in Figure 1. The BA contains the nuclear system and the electrical component assembly. [redacted]

[redacted]

The case of the BA is an aluminum structure that consists of two 1/2-inch thick cylindrical sections, a 1/2-inch thick conical section, two end caps, and a closure plate. The complete fuzing and firing electrical component assembly is contained in the BA between the aft end cap and the closure plate.

B. Nuclear Warhead Electrical System

[redacted]

MC1178 Laydown Timer -- The MC1178 includes two electric motors (SA377) for operation of two separate channels. Each motor operates two SA833 snap-action switches at each of three time intervals. The switches are wired so that fuzing channels are switched by either timer motor. Fire signal times from 30 to 240 seconds, in 30-second increments, can be set into the MC1178 with a

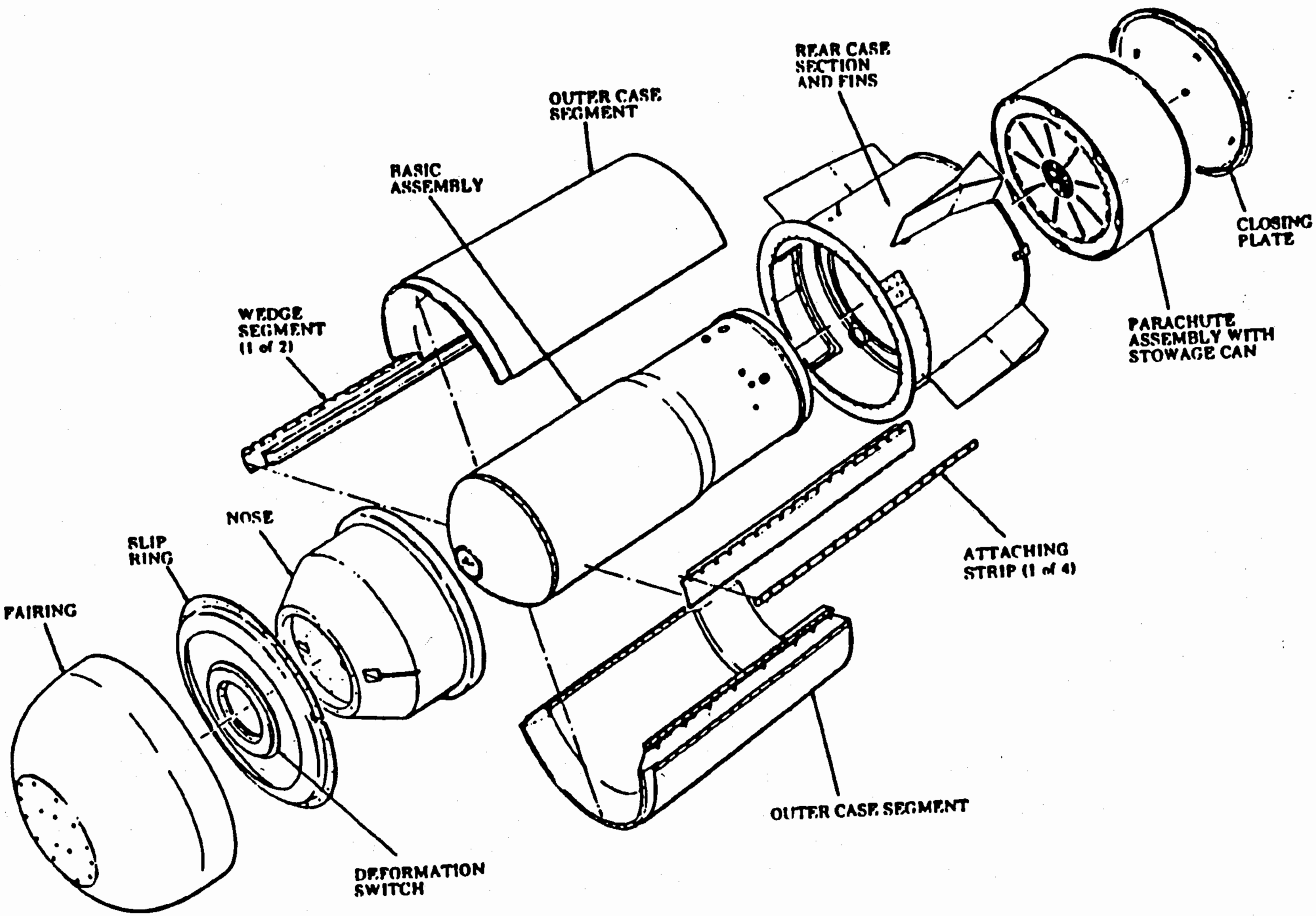


Figure 1 - B53-1 Bomb Exploded View

screwdriver. The setting on the timer indicates the time from extracton of the pullout rods and detonation. [redacted]

MC1199 Electrical System Safing Switch -- The MC1199 is manually operated external to the weapon and provides visual indication of safe or unsafe conditions during ground handling. It has three control positions: safe, retard, and free-fall. [redacted]

DOE b(3)

C

MC1204 Explosive Switch and Fuse Pack -- The MC1204 is a single package containing all of the explosive switches and electrical fuses used in the B53. It consists of four MC749 self-contained explosive switches, two SA1022 fuses, and four SA960 fuses. [redacted]

MC1237 Interconnecting Box -- The MC1237 completes the circuits between the components in the main fuzing system. This interconnecting box contains no resistors but is similar in construction to the MC1203.

MC1262 Thermal Battery Packs -- Two MC1262 fast-rise thermal battery packs are used in the B53. The MC1262 is a two-section thermal battery containing a 12-volt fast-rise section and 28-volt power section. Basically, it is two batteries in a single case with a common negative terminal. [redacted]

[redacted] DOE b(3)

MC1264 Thermal Batteries -- Two MC1264 thermal batteries are used in the B53 to provide dual channel power for the fuzing system. The MC1264 is nominally a 28-volt battery with an activated life in excess of 240 seconds. It is activated by electrical power from the 12-volt section of the MC1262 to either of the two MC1210 electrical matches in the MC1264. The SA925 thermal monitor is incorporated into the MC1264 to provide means to determine activation status of the battery.

MC1268 Interval Timer -- The MC1268 includes two MC1269 mercury-thallium switches and two SA906 motor-driven timers. [redacted] DOE b(3)

MC4065 Power Pack -- The MC4065 contains a high voltage transverter, a trigger circuit, the neutron generator low voltage oscillator circuit and trigger attenuator, and an MC2969 Strong-Link Switch which are potted in a stainless steel housing. [redacted] DOE b(3)

MC4066 Neutron Generator -- Two MC4066 generators are used to provide external initiation of the nuclear system. [redacted] DOE b(3)

Parachute System -- The parachute system includes three mild detonating fuze (MDF) systems, a 4-foot pilot chute, a 16.5-foot ribbon-type chute permanently reefed to 12 feet (retard chute), and three 48-foot ribbon-type chutes (laydown chutes), each reefed to 22.5 feet for 2 seconds after line stretch. Each parachute is packed into its deployment bag before assembly into a parachute stowage can.

The three MDF systems provide for parachute deployment, separation of the laydown extraction parachute, and release of the complete parachute system for high-altitude free-fall option (not available in B53-1).

The parachute stowage can is a honeycomb structure that provides a parachute volume of 26 cubic feet and contains two suspension line lug systems. One of the lug systems is used to attach the laydown chutes and to provide a load-carrying path to the rear case section. The other lug system is used to attach the retard chute. It contains a cutting anvil to be used, in conjunction with the MC1581 shaped charge mild detonating fuze system (flexible linear-shaped charge) in the rear case section, to cut the retard chute suspension lines in the laydown option. Thus, the retard chute deploys the laydown chute.

C. Nuclear Explosive Safety Theme

The safety theme of the B53-1 includes energy diversion through conductive metal barriers, protection of entry into the exclusion region by a strong-link switch that is enabled by a unique signal, and weak-link/strong-link collocation.

C DOE b(3)

[redacted]

DOE b(3) S

[redacted]

- All remaining B53-1 pits in stockpile have been individually calculated to be inherently one-point safe.

- The design approach to provide isolation of critical circuits from sources of electrical energy in abnormal environments is to enclose those critical elements with an exclusion region. The entry of electrical energy into this region is through an MC2969 Strong-Link Switch that is enabled only by receipt of a unique signal. The unique signal is generated external to the bomb such that transmission of the unique signal indicates the intent to arm the B53-1.

- A Lightning Arrestor Connector is utilized at the bomb/pullout cable interface to provide protection against inputs to the bomb that could result from lightning strikes.

DOE b(3) C

[redacted]

SECRET

Sandia National Laboratories

Albuquerque, New Mexico 87185

date: August 2, 1993

to: J. S. Clabaugh, 5115

Dave Pierce

from: D. M. Pierce

subject: B53 Investigation of JTA Connector J7 Inputs

The MC4065 Power Pack for the B53 SIP has a JTA connector(J7) which is connected into the exclusion region. See enclosure 1. All pin connections have an isolation resistor except the ground return. The resistors are one (1) watt fixed wire wound construction. The failure mode, when over-power is to fuse open and stay open circuited. The following current/voltage/power would have to be applied to arm and fire the power pack X-unit or charge the output capacitor through the bleeder/divider network:

Function	Current-Amps	Voltage-Volts	Power-Watts
A1/B1	0.221	2,238	495
A2/B2-Peak	3.2	32,028	102,489
A2/B2- Steady State	0.225	2,318	502
A3/B3	0.032	330	10.5
TM Bleeder/ Divider	0.029	146,760	31.5

As can be seen from the above table, the one watt input resistors would burn open and the circuit would be unable to supply current for arming and firing functions.

If you have further questions please call me on extension 5-8317.

DMP:2571

Copy/Enclosures to:
2571 W. C. Curtis
2571 T. J. Williams
2571 D. M. Pierce

SECRET

SECRET

WX-1-E-93-410S -1- August 27, 1993

Los Alamos
NATIONAL LABORATORY

Weapon Engineering
WX-1, MS C936
Los Alamos, New Mexico 87545
(505)667-6300
FAX (505)667-5121

LOS ALAMOS SOURCE DATA FOR B53 MOD 1

NUCLEAR EXPLOSIVE SAFETY STUDY (U)

BY:

E. D. Aragon, Jr.
B53 Project Leader
GROUP WX-1

Prepared for the DOE/AL B53 NESS to be held at
the Pantex Plant on September 28, 1993

EDA:pam
Distribution:
A. A. Nichols, Attn: F. W. Rider, DOE/AL
D. E. Zimmerman, DP-20.1, DOE/HQ,
E. R. Hanson, DOE/NV
L. J. Thompson, DOE/AAO
T. J. Morris, Battelle/Pantex Plant
J. E. Fullerton, M&H 12-107, Pantex (8 copies)
T. K. Devlin, L-125, LLNL
R. L. Samuelson, L057, DOE/SAN, c/o LLNL
S. D. Spray, Org. 331, SNLA
J. Harrison, Org. 5115, SNLA
J. L. Bellows, DOE/LAAO, MS A316
CRM-4, MS A150
J. M. Holt, Jr., NWT/NWP, MS F630
T. P. McLaughlin, HS-6, MS F691
R. D. Johnson, X-4, MS F664
B. P. Ginsberg, M-7, MS P952
J. J. Ruminer/H. L. Flaugh, WX-DO, MS P945
L. M. Kelly, WX-DO, MS P945
T. D. Robinson, WX-5, MS G780
D. L. Jaeger, WX-1, MS C936
W. J. Higgins, WX-1, MS C936
E. D. Aragon, Jr, WX-1, MS C936
WX-1 File Cy: Vault - B53, I 18

RESTRICTED DATA
This document contains Restricted Data as defined in the Atomic Energy Act of 1954. Unauthorized disclosure subject to Administrative and Criminal Sanctions.

SECRET

DERIVATIVE CLASSIFIER

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont.)

DOE b(3)

LIST OF ILLUSTRATIONS

I. APPLICATION AND GENERAL DESCRIPTION

[redacted] The B53 was also fielded as a basic assembly (BA53Y1) for the B-58 pod application. [redacted] DOE b(3)

[redacted] DOE b(3)

The bomb does not incorporate Insensitive High Explosive (IHE) or a Command Disablement system.[1]

The B53 physical characteristics are listed below:

Weight:	8890 lb
Length:	144.6 in.
Maximum Diameter:	50 in.

[redacted] DOE b(3)

II. NUCLEAR SYSTEM DESCRIPTION

[redacted] The "basic assembly" includes the nuclear system and the weapon electrical system (WES), designed by Sandia National Laboratories (SNL). [redacted] A cut-away of the B53 is shown in Figure 1. Hazardous materials contained in the physics package are listed in Table 1. DOE b(3) DOE b(3)

The data show that the Cyclotol/Comp. B HE sensitivity levels fall in the mid to less sensitive portion of the tables presented. This is best shown by the Susan tests (Figs. 8 & 9). In these tests, Cyclotol and Comp. B are less sensitive than the HMX based PBX HEs. However, they are not as insensitive as PBX 9502 (IHE). The skid drop height of 10 and 4 ft respectively is surprising as compared to the spigot drop test height of 85 ft for Comp B and > 150 ft. for Cyclotol. The skid drop height is used for bare HE handling.

For thermal abnormal environments, several full scale weapon system tests contining Cyclotol as the main charge have been evaluated. These evaluations include both fuel fire tests and accidents. In all of these cases, the Cyclotol did not detonate. The following is a list of these fuel fire test and accidents.

Fuel Fire Tests

1.	W25	(6 tests)	No detonation, HE burned
2.	B28	(1 test)	No detonation, HE burned
3.	W53	(1 test)	No detonation, He burned

Accidents

1.	Bunkerhill (1964)	No detonation, HE burned
2.	McGuire (1960)	No detonation, HE burned

DOE b(3)

Four accidents involving impacts have occurred that involved cast HE systems where Cyclotol was the main HE charge. Of these four events, one accident did involve HE detonation. The following lists these accidents.

Accidents Involving Impacts

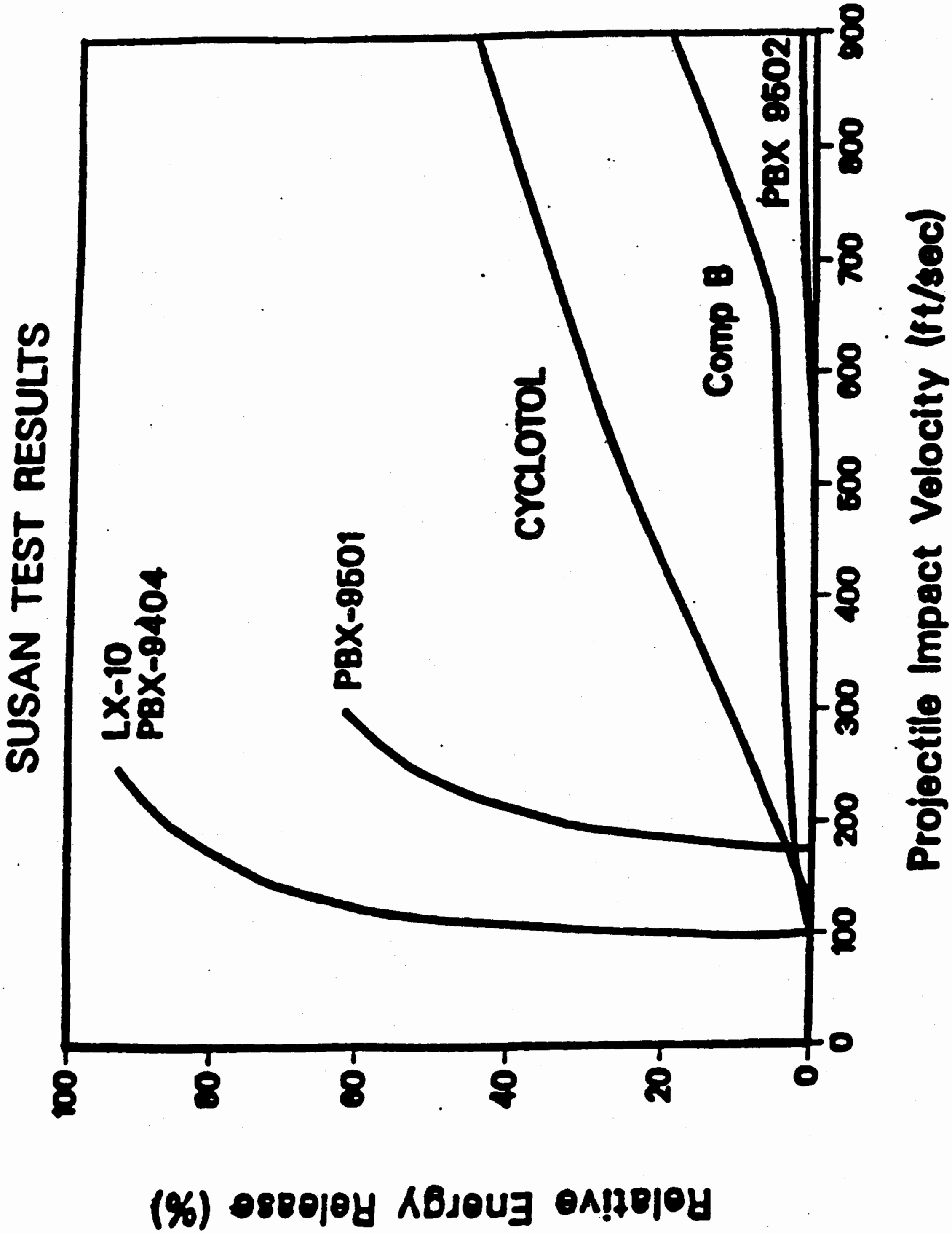
1.	Cumberland, MD. (1964)	No fire, No detonation
2.	Palomares, Spain (1966)	2 detonated on impact
3.	Thule, Greenland (1968)	No detonation, bombs destroyed by fire
4.	Damascus, Ark. (1980)	No detonation, unit recovered intact

DOE b(3)

HE Degradation

Selected properties of Cyclotol and Comp. B have been evaluated from aged stockpile materials and local testing. These evaluations have indicated that the material still performs as good as new. There are no signs of degradation from aging or incompatibility.

SECRET



Los Alamos

Fig. 9 - Susan Test Results

SECRET

Detonators

Samples of all DOE detonators are tested during development by thermal cycling, temperature shock, vibration, and acceleration primarily for reliability assessment. These tests also relate to the safety aspects of the detonators. The 1E26 detonator assembly has successfully passed all the environmental tests. Additionally, these detonators have been routinely sample tested during preproduction, production, and stockpile sampling with no deficiencies in safety or operational aspects noted.

Valve Safety

The Type 1A valve is actuated by Type 1A squibs. A piston is driven down through the bore that severs the pit and the bottle tubes allowing boost gas to enter the pit. This valve poses no explosive safety concerns because all the reaction products and the pistion motion are contained within the valve body. The actuators are designed to function under a 28 volt source with a 500 ma all-fire and a 150 ma no-fire current rating.

Actuator ESD Sensitivity

These actuators are known to be sensitive to electrostatic discharge (ESD) when tested with a standard ESD pulse (20kV, 500 pF through 500 ohms) pin-to-case. Tests of the Type 1A squibs have resulted in failure to pass ESD pin-to-case tests with conditions of 5 kV, 500 pF through 500 ohms. Therefore, special bonding practices during all assembly/disassembly operations are required, and shorting plugs should be in place at all times after the firing cables are disconnected.

IV. CRITICALITY SAFETY

Single Units

[redacted] From a criticality perspective, this all-uranium pit has three characteristics which distinguish it from Pu pits found in the stockpile. However, all pits of Los Alamos origin, whether they contain uranium, Pu, or both as the fissile material, only pose a criticality hazard (as single units) during extreme accidents involving water flooding inside the pit. DOE b(3)

Type 76 Pit

The three distinguishing characteristics are:

- Uranium is corroded much more slowly by water than is Pu, either alpha or delta.
- Uranium is attacked much more slowly by H_2 gas than is Pu, either alpha or delta.
- [redacted] DOE b(3)

The implication of these first two points is that prompt recovery (i.e. few days or less) of a B53 from a water environment precludes any credible criticality concerns. That is, insufficient uranium corrosion and hydriding will have occurred to give rise to the hazards discussed (for Pu) in the TP 60-1 manual, particularly section 3-2.5, flooding/criticality. Obviously, if water has not entered the pit then there are no criticality concerns even for prolonged underwater conditions. However, if a unit is involved in an accident leading to even possible internal flooding, then it would seem prudent to assume such.

The two extremes from a criticality standpoint are full water reflection outside [redacted] and essentially zero reflection outside. For these cases, minimum conditions are: DOE b(3)

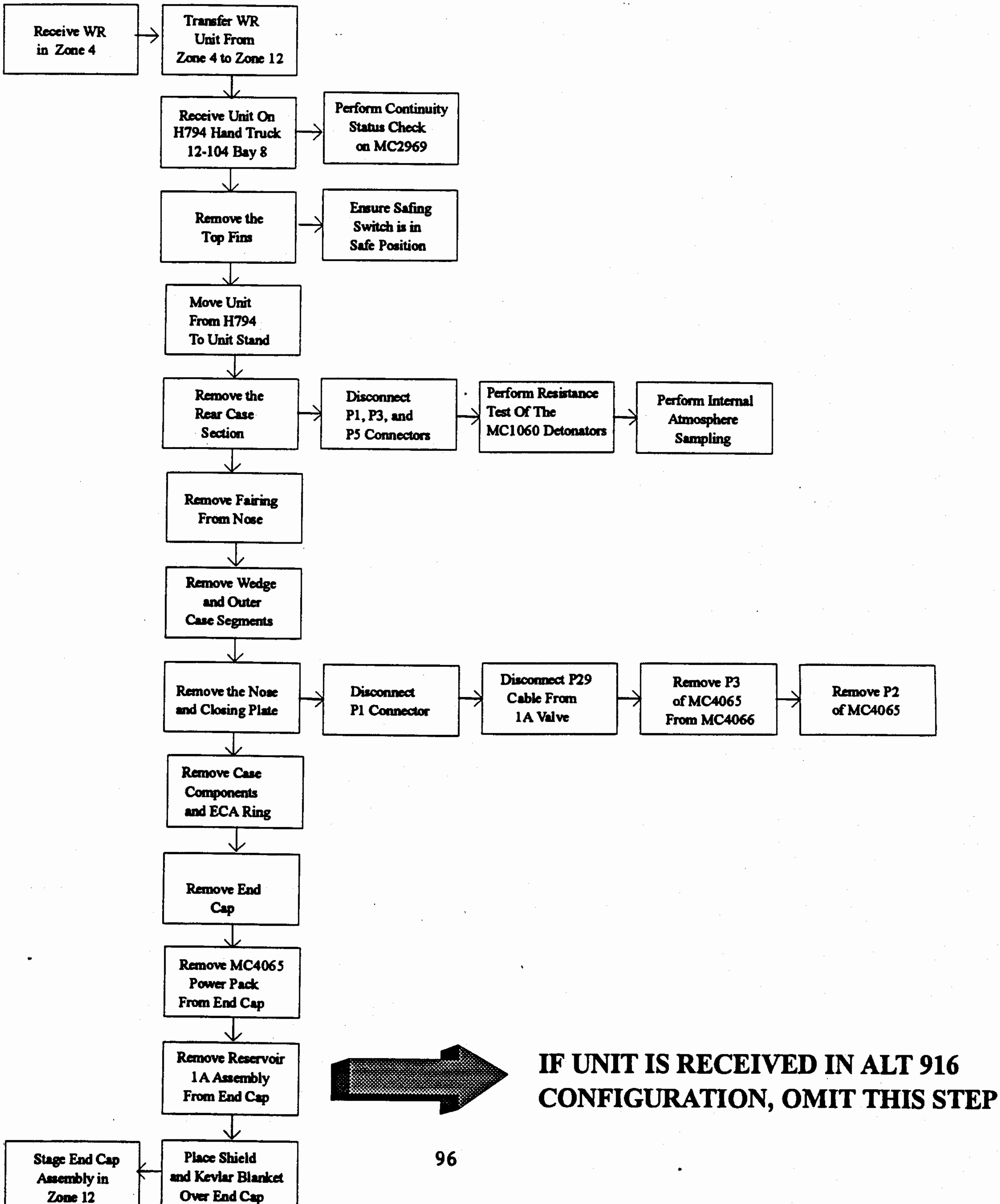
Reflected

DOE b(3) [redacted]

Bare

DOE b(3) [redacted]

B53-1 PARENT UNIT PARTS DISASSEMBLY



UNCLASSIFIED